Does encapsulation of DHA with heat-denatured whey proteins in Pickering emulsions improve its bioaccessibility?

Jun Wang, Gwenaële Henry, Olivia Ménard, Jordane Ossemond, Yann Le Gouar, Sébastien Lê, Ashkan Madadlou, Didier Dupont, Frédérique F. Pédrono

Does encapsulation of DHA with heat-denatured whey proteins in Pickering emulsions improve its bioaccessibility?

Jun Wang[1,2], Gwenaële Henry[1,2], Olivia Ménard[1,2], Jordane Ossemond[1,2], Yann Le Gouar[1,2], Sébastien Lê[2], Ashkan Madadlou[3], Didier Dupont[1,2], Frédérique Pédrono[1,2]

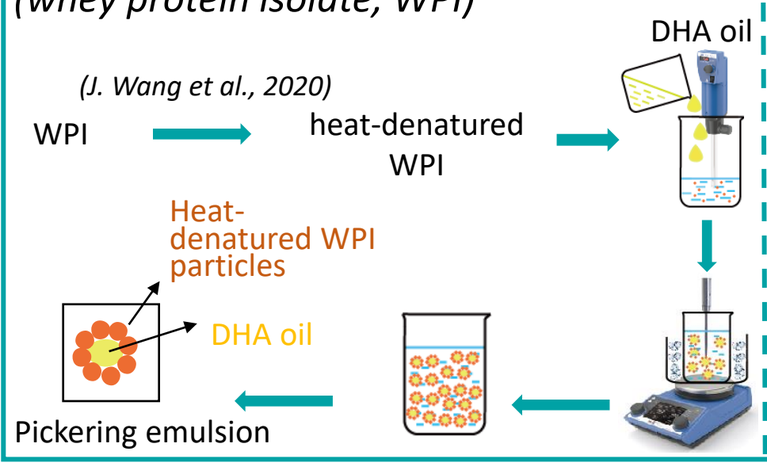
1. INRAE, UMR 1253 STLO, 65 rue de Saint-Brieuc, F-35000 Rennes, France 2. Institut Agro, Agrocampus Ouest, 65 rue de Saint-Brieuc, F-35000 Rennes, France 3. Norwegian University of Science and Technolygy, 39000, Norwegian

Background

- **DHA** is the most important n-3 polyunsaturated fatty acids (PUFAs), mainly known for its health benefits on cognitive development and cardiovascular function. The **current intake** of DHA and EPA in the Western diet averages **150 mg** per day, less than the **recommended** daily consumption from The French Food Safety Authority for adults, which is **500 mg**.
- **Oxidation** limits the enrichment of n-3 PUFAs in foods. **Encapsulation** is an effective strategy to strengthen food with n-3 PUFAs, and can also improve the oxidative status. **Pickering emulsion** has garnered exponentially increasing interest in recent years due to its excellent stability.
- **Omelets** have the **highest DHA bioavailability** in various forms of DHA-rich foods (omelet, mousse, hard egg) *(Pineda-Vadillo et al., 2021).*
- In this study, **encapsulated** and **unencapsulated** DHA oil were added to omelets respectively to obtain DHA-rich foods. Then we measured the impact of **encapsulation** of the DHA oil on the digestion of DHA carried on **triacylglycerol (TAG).** We used an *in vitro* model of **static digestion** for adults *(Infogest, (Minekus et al., 2014)).*

Materials & Methods

Pickering emulsion preparation (whey protein isolate, WPI)



Omelet preparation

10000 r/min 30 s

With heat-denatured WPI dispersion **(Control)**

With unencapsulated DHA oil + heat-denatured WPI dispersion **(UN-DHA-O)**

With encapsulated DHA oil **(EN-DHA-O)**

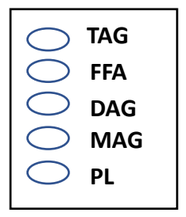
Omelet digestion, microstructure and lipid analysis

Model for adult: static *(Infogest, (Minekus et al., 2014))*
Gastric phase: pepsin and rabbit gastric lipase (RGE)
Intestinal phase: pancreatin

microscopy (CLSM)

DHA oil stained with Nile Red and proteins stained with Fast Green

lipid extraction (Folch)



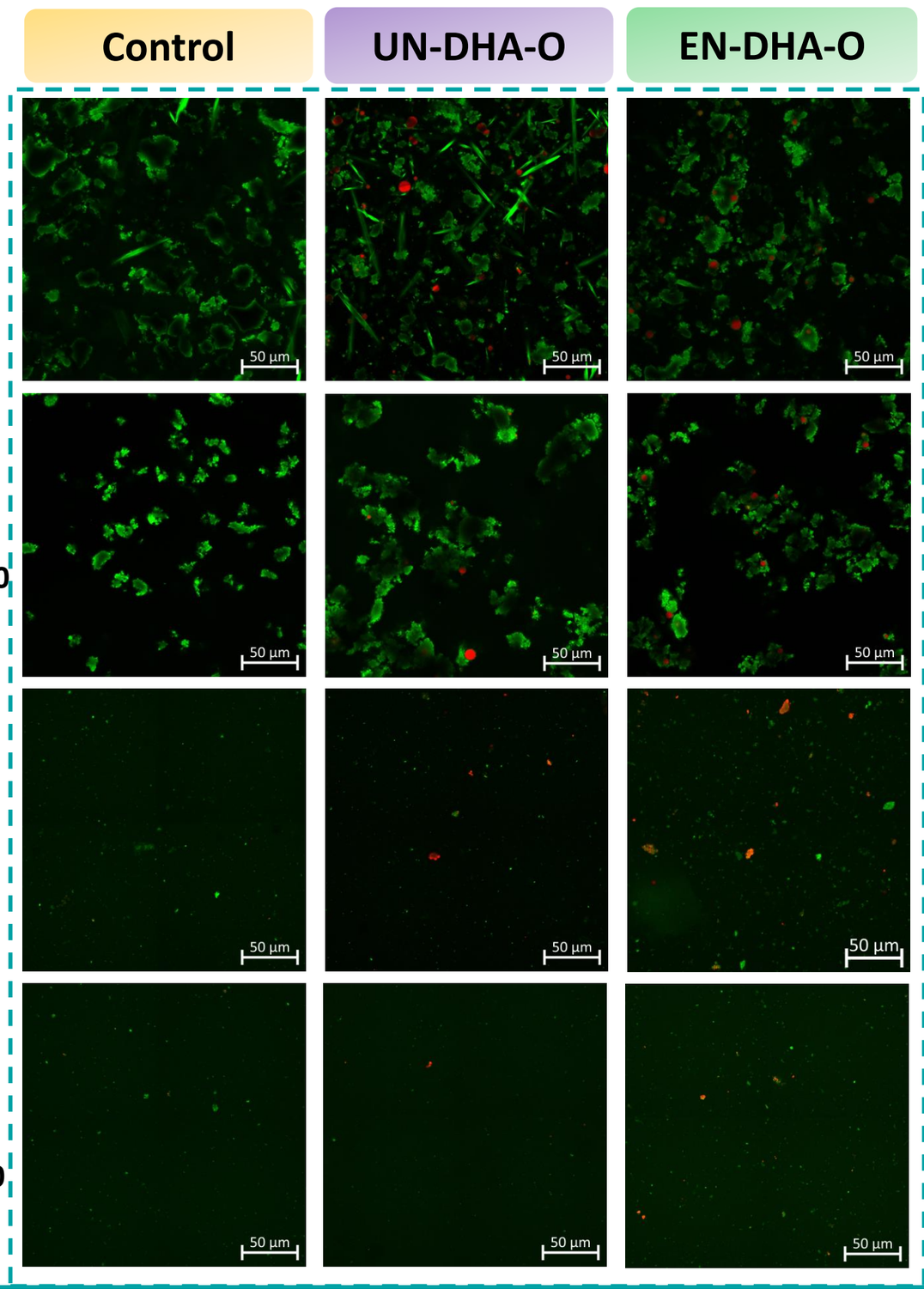
saponification

methylation

GC-MS

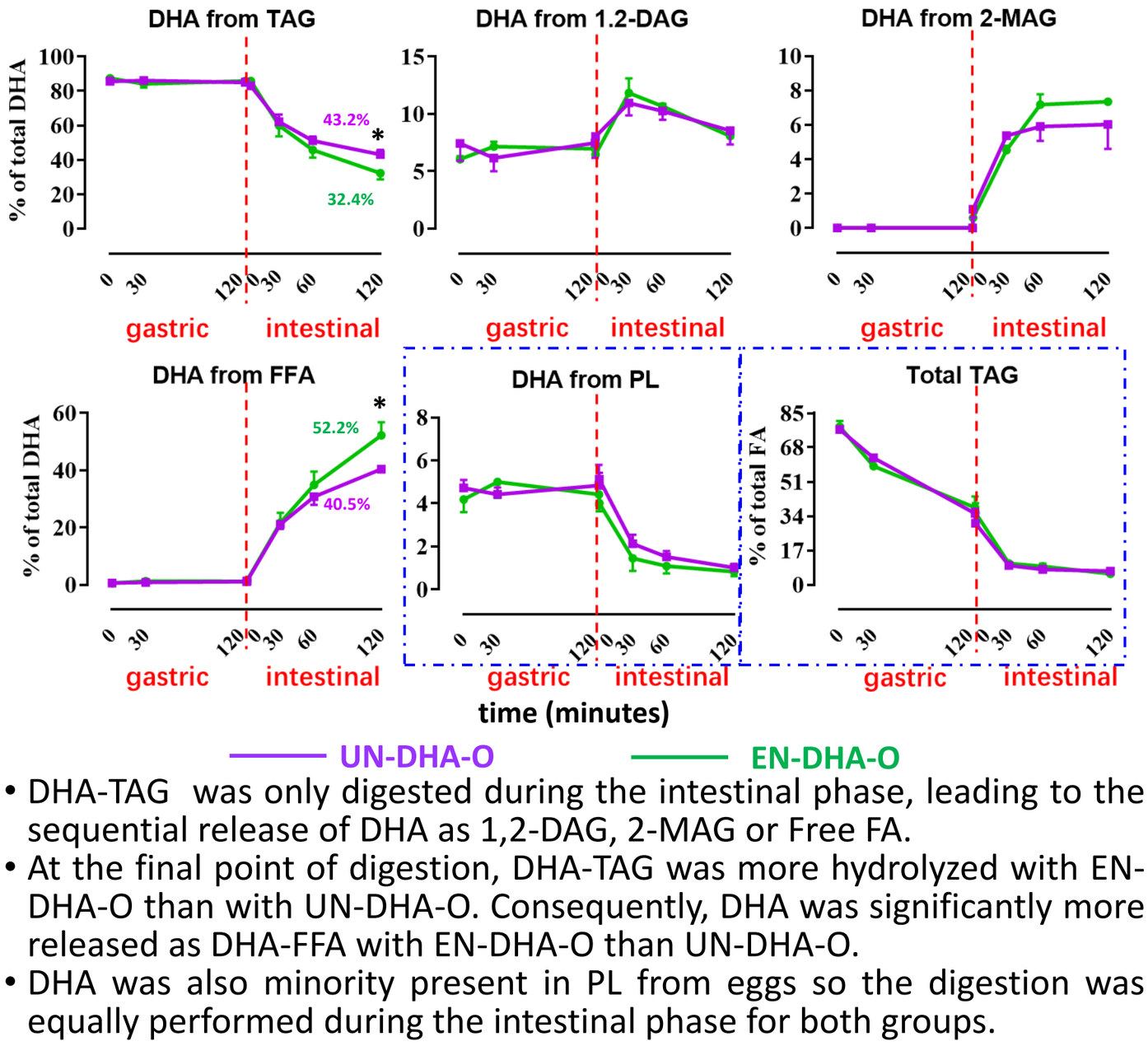
Results & discussion

The distribution of DHA oil in omelets during the digestion



- Droplets of DHA oil were uniformly sized and equally distributed in omelets with EN-DHA-O, contrary to UN-DHA-O.
- Digestion of the DHA oil occurred during the intestinal phase but without discrimination between groups.

The evolution and bioaccessibility of DHA during the digestion



- DHA-TAG was only digested during the intestinal phase, leading to the sequential release of DHA as 1,2-DAG, 2-MAG or Free FA.
- At the final point of digestion, DHA-TAG was more hydrolyzed with EN-DHA-O than with UN-DHA-O. Consequently, DHA was significantly more released as DHA-FFA with EN-DHA-O than UN-DHA-O.
- DHA was also minority present in PL from eggs so the digestion was equally performed during the intestinal phase for both groups.

Conclusions

- **Our results showed that DHA-TAG was only digested in the intestinal phase as compared to the other TAG present in omelets.**
- **Encapsulation of the DHA oil enhanced the lipolysis of DHA-TAG. The lipase activity was probably improved because of a higher oil-water interfacial area due to the smaller droplets observed in the EN-DHA-O group.**

Jun.wang@inrae.fr
Didier.dupont@inrae.fr; Frederique.pedrono@agrocampus-ouest.fr